Development of a sustainable intensification indicators framework: reports from the frontline in Malawi

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Background

An emerging area of science is 'Sustainable Intensification', with a focus on efficient use of resources for agriculture, with equal attention to equity and environmental services. Indicators of SI are needed to assess progress towards these goals. The indicators must be widely recognized and have practical methods that can be used easily by scientists from various disciplines.

The aim of this multi-disciplinary project is to develop SI indicators through interaction with scientists, extension, students, and partners of projects supported by USAID Feed the Future and through literature review.

The five domains of the SI indicators include: productivity, economics, environment, social, and human condition (Table 1). Three scales include field level, farm/household level, and community or regional level (Table 2). Scientists widely agreed on the need for measuring indicators across all five domains but many are unfamiliar with how to measure the indicators outside of their specialization.

The Africa RISING project in Malawi served as an initial case study to quantify SI trajectories and to compare the relative sustainability of agricultural practices. Africa RISING in Malawi supports SI of maize-based, rainfed farming systems to improve:

- Food security and nutrition
- Farmer livelihoods and capacity
- Agroecological health

Table 1. Five domains and indicators are shown for assessment of SI progress.

Domain	Indicators
Productivity	Yield Livestock productivity Yield variability
Economics	Profitability Labor
Environmental	Soil organic matter Nutrient budgets Biodiversity
Human Condition	Nutrition Food Security
Social	Capacity Gender equity Social conflict

Field

Farm/Household

Community or Region

Figure 1.

Three scales for which the project is developing SI indicators.

Methods

Africa RISING participatory action sites in Central Malawi were selected as representative of marginal to mesic environments typical of smallholder production under unimodal precipitation with limited market access. Initiated in 2012, action research with over 1,400 farmers has focused on introducing improved legume crops and integrated nutrient management.

Capacity building and farmer experimentation, including gender-aware training, were carried out through the mother and baby participatory research approach (Snapp et al., 2002) at four sites, with 32 mother trials and over 1,400 baby trials.

Here we present data for three of the researched cropping systems:

1. Unfertilized continuous maize
2. Fertilized continuous maize (69kg N/ha)
3. Maize intercropped with pigeonpea with half the fertilizer (35kg N/ha)

APSIM modeling with 25 years of meteorological data was used to estimate long-term trends in soil changes as well as the probabilities of food sufficiency and crop failure (Smith et al. 2016).

Figure 2.

Mother and baby trial design to foster communication and farmer experimentation. Used by Malawi Africa RISING scientists to systematically assess on-farm performance, farmer rating of technologies, and crop and soil model calibration.

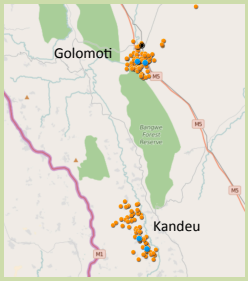

Figure 3.

Central Malawi Africa RISING: Two of the four action research sites, with mother and baby trial locations shown. More information at: http://globalchangescience.org/eastafricanode/
Photos below of on-farm experimentation.

Results

Radar charts of SI indicators in figure 4 show that intercropping with pigeonpea can improve the sustainability of the soil without sacrificing farmers' ability to meet their consumption and income goals. The incorporation of the legume biomass contributes to stable maize yields and lower fertilizer costs. Gender ranking of technologies and modeled soil response varied by location and provided unique insights.

At Kandeu (high potential site) soil carbon and nitrogen levels increased with pigeonpea intercrop over 25 years, and produced substantially more biomass and legume grain yield than at Golomoti (low potential site).

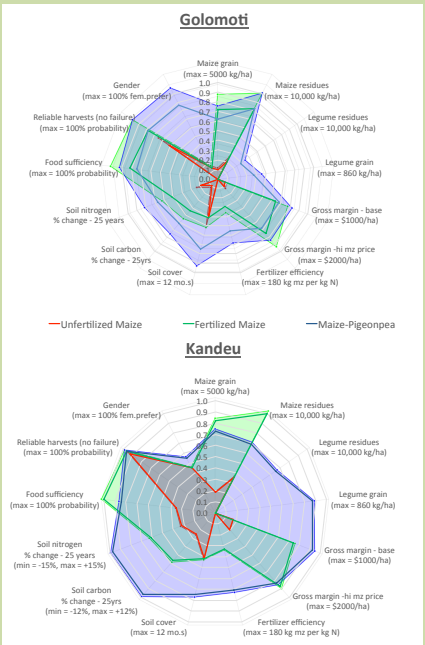

Figure 4.

Performance of maize-pigeonpea intercrops compared to fertilized and unfertilized sole maize in two locations across five domains of SI (productivity, environment, economics, human and social)

Conclusions

This analysis of sustainable intensification for maize based systems in Malawi has demonstrated the importance of assessing sustainability in a holistic way. The analysis of SI indicators supported critical thinking beyond hypothesis testing to consider tradeoffs and synergies as they relate to the diverse objectives of farmers and the broader society.

Acknowledgements

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